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(56) Documents Cited by ISA

EP 0783074 A2	WO 1998/049423 A1
US 6263966 B1	US 6109349 A
US 5992518 A	US 5901789 A
US 5899271 A	US 5749605 A
US 5007665 A	US 4865359 A
US 4095825 A	

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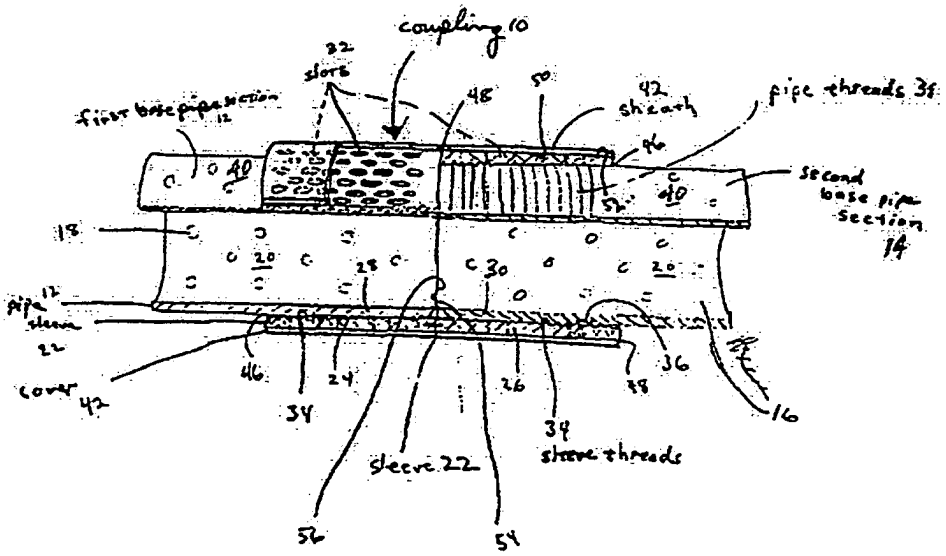
(54) Abstract Title
Expandable coupling

(57) Disclosed are apparatus and methods for mechanically coupling two sections of radially expandable pipe providing a sand-controlling joint. Generally, a radially expandable coupling is disposed between and coupled with two sections of radially expandable pipe. The coupling includes a radially expandable sleeve having a first end and a second end, both ends having locking mechanism portions corresponding to pipe section ends. The coupling may include expansion slots or a sheath encasing the radially expandable sleeve. Methods are provided for coupling two sections of radially expandable pipe using a radially expandable coupling providing a sand-controlling joint between the pipe sections both before and after expansion.



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EXPANDABLE COUPLING

TECHNICAL FIELD

The present inventions relate to sand-control apparatus for use in subterranean wells, and in particular contemplate improved mechanical apparatus for coupling sections of radially expandable pipe and methods of using the same.

BACKGROUND OF THE INVENTIONS

The control of the movement of sand and gravel into a wellbore has received much attention in the oil production industry. The introduction of sand or gravel into the wellbore commonly occurs under certain well conditions. The introduction of these materials into the well causes problems including, plugged formations or well tubings, and erosion of tubing and equipment. There have therefore been numerous attempts to prevent the introduction of sand and gravel into the production stream.

A common method to prevent the introduction of sand and gravel into the production stream has been a procedure known as gravel packing. In general, this involves placing a selected sand or gravel into the annular space between the wellbore and a base pipe introduced into the wellbore for that purpose. The base pipe contains perforations designed to allow well fluids to flow into the base pipe while excluding other material. A sand-control screen is commonly used in conjunction with a base pipe. An appropriately sized screen is commonly formed into a jacket and wrapped around the outside of the base pipe to prevent the entry of sand. Exemplary apparatus and methods of connecting a sand-control screen jacket assembly to a base pipe are disclosed in United States patent Number 5,931,232, and United States Patent Application Number 09/602,387 which are assigned to

this assignee and are incorporated herein for all purposes by this reference thereto.

One method of enhancing production in a well using a sand-control screen jacket assembly includes causing the radial expansion of the base pipe and surrounding screen jacket assembly by drawing a mechanical expansion tool through the base pipe. A problem in the art associated with radially expandable base pipes lies in providing a suitable coupling between base pipe sections. Standard couplings are subject to separation or fracture upon expansion, which can lead to the introduction of sand and gravel into the production stream. There is a need for joining sections of base pipe with a coupling that will retain sufficient strength and sand-controlling properties subsequent to radial expansion of the base pipe sections and coupling.

Due to the aforementioned problems with the introduction of sand and gravel into the production stream, a need exists for apparatus and methods providing a robust mechanical sand-controlling coupling between sections of base pipe. Such a coupling should withstand downhole production conditions including the stresses caused by installation and radial expansion.

SUMMARY OF THE INVENTIONS

In general, the inventions provide apparatus and methods for coupling sections of radially expandable pipe. The apparatus generally employs a radially expandable sleeve coupling for joining ends of two radially expandable pipes. The expandable coupling may maintain a sand-controlling joint between the pipe sections.

According to one aspect of the invention, the coupling includes a sand-controlling sheath operably encasing a radially expandable sleeve.

According to another aspect of the invention, the radially expandable sleeve is provided with expansion slots.

According to yet another aspect of the invention, the radially expandable sleeve has threads in its inner surface for operably engaging corresponding threads in the outer surface of the two pipes.

According to still another aspect of the invention, the radially expandable sleeve is configured to provide pin-and-bell joints between the coupling ends and pipe ends.

According to still other aspects of the invention, methods are provided for coupling two sections of radially expandable pipe including the steps of inserting and securing the end of a first radially expandable pipe section into a first end of a radially expandable sand-controlling sleeve, and inserting and securing an end of a second radially expandable pipe section into a second end of the radially expandable sand-controlling sleeve. Methods for expanding all expandable pipe assembly are provided.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are incorporated into and form a part of the specification to illustrate several examples of the present inventions. These drawings together with the description serve to explain the principals of the inventions. The drawings are only for the purpose of illustrating preferred and alternative examples of how the inventions can be made and used and are not to be construed as limiting the inventions to only the illustrated and described examples. The various advantages and features of the present inventions will be apparent from a consideration of the drawings in which:

FIGURE 1 is a longitudinal partial cross-sectional view of two sections of pipe and a coupling according to the invention; and

FIGURE 2 is a longitudinal partial cross-sectional view of the two sections of pipe and

coupling shown in Figure 2 undergoing expansion.

DETAILED DESCRIPTION

The present inventions are described by reference to drawings showing one or more examples of how the inventions can be made and used. In these drawings, reference characters are used throughout the several views to indicate like or corresponding parts.

In the description which follows, like or corresponding parts are marked throughout the specification and drawings with the same reference numerals, respectively. The drawings are not necessarily to scale and the proportions of certain parts have been exaggerated to better illustrate details and features of the invention. In the following description, the terms "upper," "upward," "lower," "below," downhole," "longitudinally" and the like, as used herein, shall mean in relation to the bottom, or furthest extent of, the surrounding wellbore even though the wellbore or portions of it may be deviated or horizontal. Correspondingly, the "transverse" or "radial" orientation shall mean the orientation perpendicular to the longitudinal orientation. In the discussion which follows generally cylindrical well, pipe and tube components are assumed unless expressed otherwise.

Referring generally to Figures 1 and 2, the general structure of a coupling 10 joining a first pipe section 12 and a second pipe section 14 utilizing the present inventive concepts is shown. It will be obvious to those skilled in the arts that the opposite ends (not shown) of the pipes 12, 14 may be constructed in any conventional manner or in the same manner as the end described, and that the pipe sections described may be joined to a conventional pipe string. In the preferred embodiment of the invention, radially expandable base pipe sections 12, 14 are coupled directly to one another to form a continuous base pipe 16. Of course additional sections and couplings may be used to form base pipes of any desired length. The base pipe 16 has a plurality of perforations 18

through which fluids in the well enter the interior of the base pipe 20. The number and configuration of the perforations 18 is not critical to the invention so long as a balance between fluid production and pipe integrity is maintained. The base pipe sections are provided in lengths suitable for shipping and handling. The pipe sections are then joined with couplings at the well site to create a pipe string of the desired length. At one or both ends, the base pipe string may be coupled to non-expandable tubing, usually used in non-production zones of the wellbore.

Now referring primarily to Figure 1, the coupling 10 has a radially expandable sleeve 22 designed to expand in proportion to the expansion of the base pipe 16. The sleeve 22 has a first end portion 24 and a second end portion 26 designed to accept the pipe section end portions 28, 30 respectively. The sleeve 22 is preferably made of metal and has expansion slots 32 to facilitate radial expansion. The slots may be primarily longitudinal as shown in Figure 1, but may optionally be round, helical, or another shape, so long as radial expansion is provided for. Optionally, the expansion slots may be in the form of grooves in the surface of the sleeve rather than all the way through the sleeve wall as shown.

The first and second sleeve ends 24, 26 and corresponding first and second pipe section ends 28, 30 are designed to provide a locking mechanism between the sleeve 22 and the pipe sections 12 and 14. Preferably, the locking mechanism has threads 34 on the inner surface 36 of the sleeve ends 24, 26 and complementary threads 38 on the outer surfaces 40 of the pipe section ends 28, 30. The threaded end portions 24, 26, 28, 30 of the sleeve 22 and pipes 12, 14 may form a pin-and-bell joint. Alternative to the preferred female-female configuration, the coupling may be configured in a male-male or male-female manner. Other locking mechanisms may also be used such as interlocking pin-and-socket mechanisms or corresponding set screws and threaded holes.

Other locking mechanisms are generally known in the art. A sheath 42 may be used to

concentrically encase the radially expandable sleeve 22. The sheath 42 preferably forms a sand-controlling joint with the expandable sleeve 22. The sheath 42 is preferably made from an elastomeric material but may be made of a sufficiently expandable piece of sheet material. The use of a sheath is particularly advantageous in that the coupling can be made more readily expandable without sacrificing sand-controlling properties.

Now referring primarily to Figure 2, the radial expansion of two sections of radially expandable pipe 12, 14 and coupling 10 is shown. The end portion 28 of the first pipe section 12 is inserted and secured in the first end 24 of the coupling sleeve 22. The end portion 30 of the second pipe section 14 is likewise inserted and secured in the second end 26 of the sleeve 22. As shown in Figure 2, an expansion tool 44 may be propelled through the pipe 16 causing the radial expansion of the pipe sections 12, 14 and coupling 10. The expansion tool may be an expansion cone or "pig" known in the arts, the configuration of which is not crucial to the invention. The expansion tool 44 is used to cause the expansion of the pipe 16 and coupling 10 to a larger diameter pipe 17 and coupling 11.

Upon radial expansion, the expansion slots 32 in the sleeve 22 distort to facilitate radial expansion of the sleeve 22 without failure of the sleeve material. The sleeve 22 expansion is proportional to the expansion of the pipe 16 and preferably ensures that a sand-control joint 46 is maintained at the outer surface 40 of the pipe and the inner surface 36 of the sleeve. If an optional sheath 42 is used, a sand-controlling joint 48 may be maintained between the inner surface 50 of the sheath and the outer surface 52 of the sleeve. In either case, the sand-controlling joint is sufficiently close-fitting to exclude sand particles of predetermined size desired to be excluded from the production stream, but not necessarily fluid tight. The joint 46 between the sleeve 22 and the pipe sections 12 and 14 are preferably sand-controlling, but may merely present a tortuous path

for sand leakage. Such a Tortuous path would reduce sand-control leakage as fluid flowed more readily through the perforations 18. As the expanded pipe 17 and coupling assembly 11 are radially expanded, they preferably maintain a sand-controlling fit. Each pipe section 12, 14 has a respective terminal end 54, 56 inside the sleeve 22. The terminal ends 54, 56 may be within sand-controlling proximity or in contact with one another as shown in Figures 1 and 2 creating a pipe-to-pipe sand-control joint. Optionally, the terminal ends of the pipe sections may be separated beyond sand-controlling proximity so long as sand-controlling joints are provided at the junction of the pipe and sleeve 46 and/or at the junction of the sheath and sleeve 48, preserving the sand-control integrity of the production stream.

The embodiments shown and described above are only exemplary. Many details are often found in the art such as: base pipe size, configurations and materials, the use of base pipe perforations, or the use of sand-control screen layers outside of the base pipes. Therefore, many such details are neither shown nor described. It is not claimed that all of the details, parts, elements, or steps described and shown were invented herein. Even though numerous characteristics and advantages of the present inventions have been set forth in the foregoing description, together with details of the structure and function of the inventions, the disclosure is illustrative only, and changes may be made in the detail, especially in matters of shape, size and arrangement of the parts within the principles of the inventions to the full extent indicated by the broad general meaning of the terms used in the attached claims.

The restrictive description and drawings of the specific examples above do not point out what an infringement of this patent would be, but are to provide at least one explanation of how to make and use the inventions. The limits of the inventions and the bounds of the patent protection are measured by and defined in the following claims.

WHAT IS CLAIMED:

1. An apparatus for coupling two radially expandable pipes for use in a subterranean well comprising:

two radially expandable pipes; and

a radially expandable sleeve coupled to each pipe at a sleeve connection.

2. An apparatus for coupling two radially expandable pipes for use in a subterranean well as in claim 1 wherein the sleeve connections are sand-controlling.

3. An apparatus for coupling two radially expandable pipes for use in a subterranean well as in claim 1 wherein the sleeve connections comprise pin-and-ball joints.

4. An apparatus for coupling two radially expandable pipes for use in a subterranean well as in claim 1 wherein the sleeve connections comprise threads on the outer surface of each pipe and corresponding threads on the inner surface of the sleeve.

5. An apparatus for coupling two radially expandable pipes for use in a subterranean well as in claim 1 wherein one of the ends of each of the two pipe abut one another at a pipe joint, the pipe joint encased by the radially expandable sleeve.

6. An apparatus for coupling two radially expandable pipes for use in a subterranean well as in claim 5 wherein the pipe joint is sand-controlling.

7. An apparatus for coupling two radially expandable pipes for use in a subterranean well as in claim 1 wherein the radially expandable sleeve comprises expansion slots.

8. An apparatus for coupling two radially expandable pipes for use in a subterranean well as in claim 1 wherein the radially expandable sleeve comprises expansion grooves.

9. An apparatus for coupling two radially expandable pipes for use in a subterranean well as in claim 1 further comprising a sand-controlling sheath encasing the radially expandable sleeve.

10. An apparatus for coupling two radially expandable pipes for use in a subterranean well as in claim 9 wherein the sand-controlling sheath is elastomeric.

11. An apparatus for coupling two radially expandable pipes for use in a subterranean well comprising:

a radially expandable sleeve having a first and second end, each end having a locking mechanism portion;

a first radially expandable pipe having a first pipe terminal end, the first pipe terminal end having a locking mechanism portion corresponding to the locking mechanism portion of the first end of the sleeve assembly for operably joining the first pipe to the first end of the sleeve at a first pipe joint; and

a second radially expandable pipe having a second pipe terminal end, the second pipe terminal end having a locking mechanism portion corresponding to the locking mechanism portion of the second end of the sleeve for operably joining the second pipe to the second end of the sleeve at a second pipe joint.

12. An apparatus for coupling two radially expandable pipes for use in a subterranean well as in claim 11 wherein the first and second pipe joints are sand-controlling.

13. An apparatus for coupling two radially expandable pipes for use in a subterranean well as in claim 12 wherein the locking mechanisms comprise pin-and belt joints.

14. An apparatus for coupling two radially expandable pipes for use in a subterranean well as in claim 12 wherein the terminal ends of the first and second pipes abut at a terminal joint.

15. An apparatus for coupling two radially expandable pipes for use in a subterranean well as in claim 14 wherein the terminal joint is sand-controlling.

16. An apparatus for coupling two radially expandable pipes for use in a subterranean well as in claim 11 further comprising a sheath encasing the radially expandable sleeve.

17. An apparatus for coupling two radially expandable pipes for use in a subterranean well as in claim 16 wherein the sheath abuts the sleeve in a sand-controlling connection.

18. An apparatus for coupling two radially expandable pipes for use in a subterranean well as in claim 11 wherein the radially expandable sleeve comprises expansion slots.

19. A method of coupling two radially expandable pipes comprising the steps of:

inserting a terminal end of a first radially expandable pipe into a radially expandable sleeve;

inserting a terminal end of a second radially expandable pipe into the radially expandable sleeve; and

securing the terminal ends of the first and second pipes to the radially expandable sleeve.

20. A method of coupling two radially expandable pipes as in claim 19 further comprising the step of encasing the sleeve with a sheath.

21. A method of coupling two radially expandable pipes as in claim 20 wherein the sheath and sleeve abut in a sand-controlling joint.

22. A method of coupling two radially expandable pipes as in claim 19 wherein the terminal ends of the first and second pipes are secured to the sleeve at sand-controlling joints.

23. A method of coupling two radially expandable pipes as in claim 19 wherein the first and second pipes are secured to the sleeve at pin-and-ball joints.

24. A method of radially expanding a pipe assembly in a subterranean well comprising the steps of:

placing a radially expanding pipe assembly downhole in a subterranean well, the pipe assembly comprising two radially expandable pipes and a radially expandable sleeve coupled to each pipe at a sleeve connection; and

radially expanding the pipe assembly.

25. A method of radially expanding a pipe assembly in a subterranean well as in claim 24 wherein the sleeve connections are sand-controlling.

26. A method of radially expanding a pipe assembly in a subterranean well as in claim 24 wherein the sleeve connections comprise pine-and-ball joints.

27. A method of radially expanding a pipe assembly in a subterranean well as in claim 24 wherein the sleeve comprises expansion slots.

28. A method of radially expanding a pipe assembly in a subterranean well as in claim 24 wherein the pipe assembly further comprises a sheath encasing the expandable sleeve.

29. A method of radially expanding a pipe assembly in a subterranean well as in claim 28 wherein the joint between the sheath and the expandable sleeve is sand-controlling.

30. A method of radially expanding a pipe assembly in a subterranean well as in claim 24 wherein the pipe assembly is expanded by an expansion tool comprising an expansion plug.

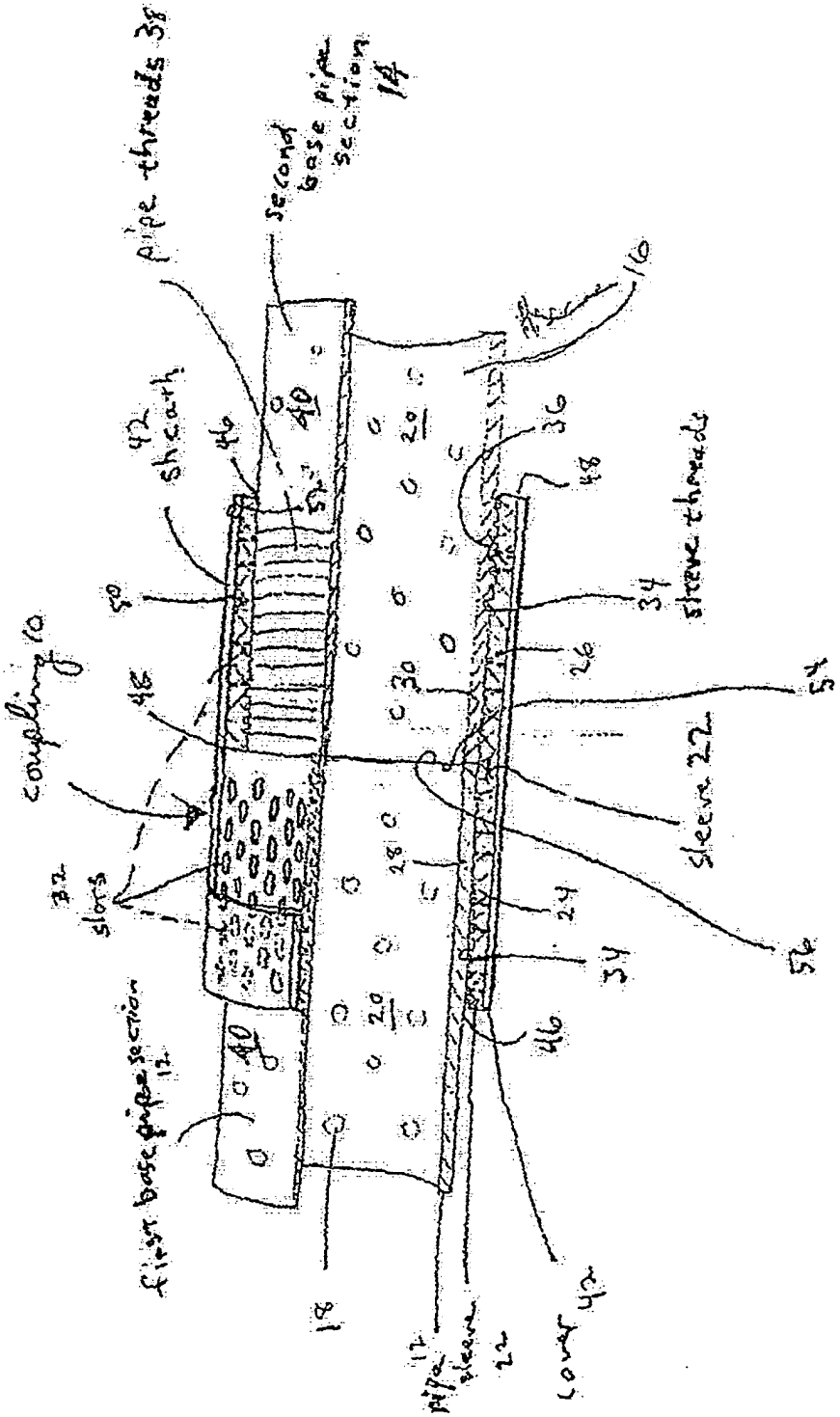
Pipe threads 38
second base pipe section 14
42 sheath
46
50
coupling 10
48
slots 32
first base pipe section 12
40
20
18
16
36
48
34
sleeve threads
26
30
54
sleeve 22
56
24
34
46
pipe sleeve 22
cover 42

Fig. 1

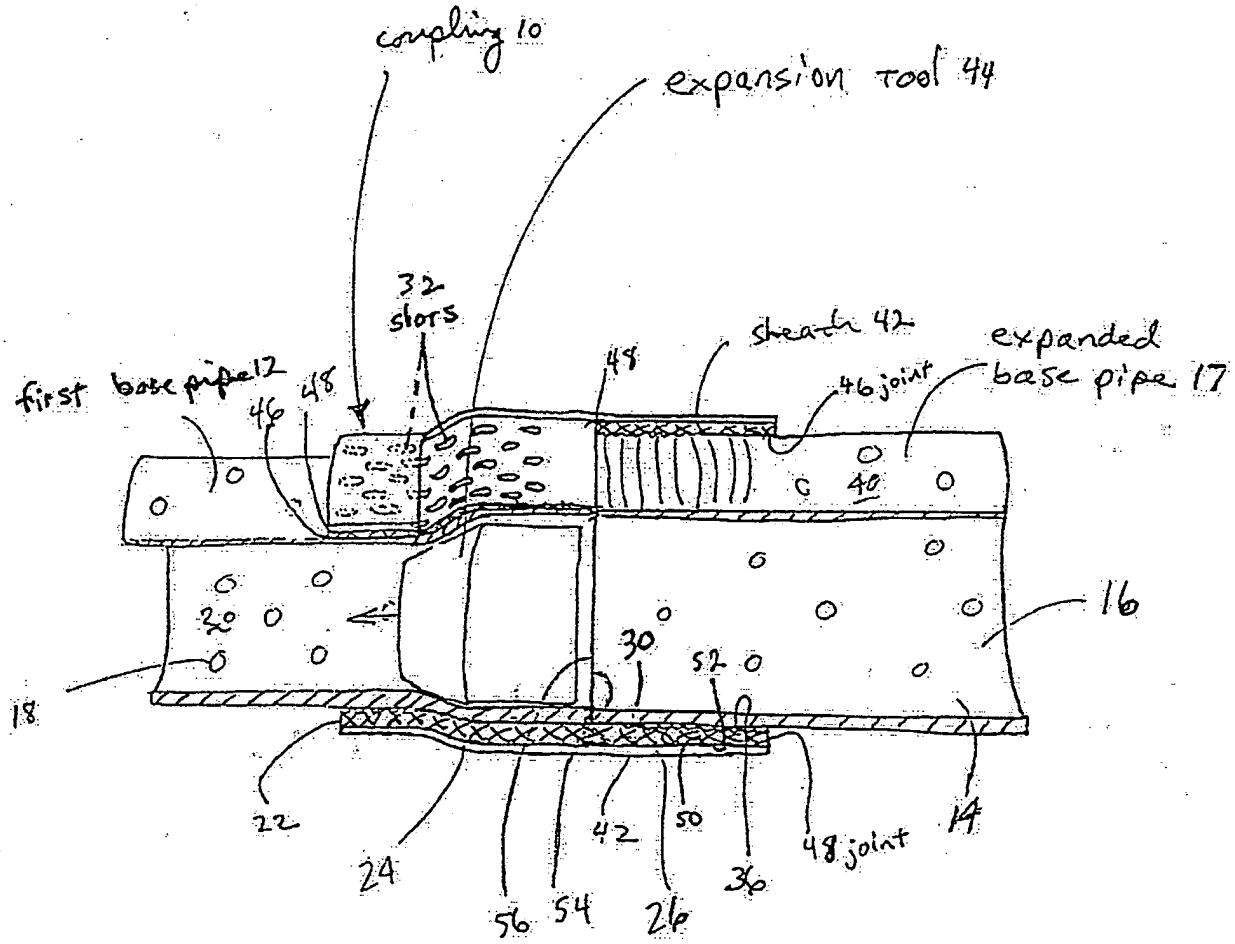
coupling 10
expansion tool 44
32 slots
first base pipe 12
46
48
49
sheath 42
46 joint
expanded base pipe 17
40
16
20
30
52
18
22
24
56
54
26
42
50
36
48 joint
14

Fig. 2